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published in

Depression and Anxiety
2016

DOI (link to publisher)

[10.1002/da.22533](https://doi.org/10.1002/da.22533)

document version

Publisher's PDF, also known as Version of record

[Link to publication in VU Research Portal](#)

citation for published version (APA)

Sijbrandij, M., Kunovski, I., & Cuijpers, P. (2016). Effectiveness of Internet-delivered cognitive behavioral therapy for posttraumatic stress disorder: a systematic review and meta-analysis. *Depression and Anxiety*, 33(9), 783-791. <https://doi.org/10.1002/da.22533>

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Review

EFFECTIVENESS OF INTERNET-DELIVERED COGNITIVE BEHAVIORAL THERAPY FOR POSTTRAUMATIC STRESS DISORDER: A SYSTEMATIC REVIEW AND META-ANALYSIS

Marit Sijbrandij, Ph.D.,^{1,2*} Ivo Kunovski, M.Sc.,¹ and Pim Cuijpers, Ph.D.^{1,2}

Background: *Internet-delivered cognitive behavioral therapy (iCBT) is a relatively novel treatment method that may improve the accessibility of mental health care for individuals with posttraumatic stress disorder (PTSD). The aim of this meta-analysis was to evaluate the effectiveness of iCBT compared to inactive (waitlist control and treatment-as-usual (TAU)) and active other interventions in reducing PTSD symptoms.* **Methods:** *A meta-analysis of 12 randomized controlled trials (14 comparisons) and 1,306 participants was conducted.* **Results:** *The pooled effect size of the 11 comparisons (10 studies, 1,139 participants) that compared iCBT to waitlist and TAU control was moderate ($g = 0.71$, 95% CI [0.49–0.93], $P < .001$), and showed moderate heterogeneity. The pooled effect size of the three studies (three comparisons) comparing iCBT to other interventions was small ($g = 0.28$, 95% CI [–0.00 to 0.56], $P = .05$), with low heterogeneity.* **Conclusion:** *The findings of this systematic review and meta-analysis show that iCBT is an effective treatment for individuals with PTSD and comorbid depressive symptoms. However, further research is needed for effective dissemination of iCBT in clinical practice.* *Depression and Anxiety 33:783–791, 2016.* © 2016 Wiley Periodicals, Inc.

Key words: *computer/internet technology; CBT/cognitive behavior therapy; PTSD/posttraumatic stress disorder; trauma; treatment; depression; life events/stress*

INTRODUCTION

Traumatic experiences such as war, natural disaster, assault, accident, or the sudden death are common in the general population, with more than two-thirds of people may be experiencing a major traumatic event in the course of their lifetime.^[1] Although the majority of individuals recover naturally, a minority develops mental health problems. The most prevalent mental health problems include posttraumatic stress disorder (PTSD) and depression.^[2,3] PTSD is a debilitating condition, which is associated with reduced quality of life, impaired social and occupational functioning, and considerable personal and societal costs.^[2]

For individuals affected by PTSD symptoms, adequate treatment is crucial for reduction of symptoms and recovery of everyday functioning. Research has suggested that trauma-focused cognitive behavioral therapy (CBT) is effective in ameliorating PTSD symptoms.^[4–6] CBT for PTSD consists of several elements. Usually,

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Received for publication 17 March 2015; Revised 18 May 2016; Accepted 22 May 2016

DOI 10.1002/da.22533

Published online 20 June 2016 in Wiley Online Library (wileyonlinelibrary.com).

psychoeducation about common reactions to trauma and anxiety management techniques such as breathing relaxation exercises, is provided. Imaginal exposure to details of the traumatic memory is assumed to result in extinction of trauma-related fear.^[7] During homework exercises, in-vivo exposure to trauma-related situations is carried out. Moreover, many CBT protocols include cognitive restructuring of maladaptive cognitions, such as perceiving the world as dangerous, seeing oneself as helpless, or feeling excessive guilt.^[8,9]

Unfortunately, only a minority of individuals with PTSD symptoms receive the necessary treatment after experiencing a traumatic event.^[4,5] Since the beginning of this century, Internet interventions have been developed for the treatment of PTSD symptoms. Internet-delivered interventions are treatments, mostly psychological, which are mainly delivered via the Internet with at least some therapeutic tasks delegated to the computer (see^[10]). They can be both therapist-assisted and self-help treatments.

It has been proposed that Internet-delivered interventions offer several advantages in the treatment of mental disorders such as PTSD. The advantages are that internet-delivered interventions may be more accessible for individuals in remote areas with long travel distance from mental health care institutions or individuals with restricted mobility.^[11] It may also be more acceptable for individuals with fear of stigmatization.^[9,12] For PTSD patients experiencing avoidance symptoms such as avoiding leaving the house or meeting other people, Internet interventions may be more acceptable than face-to-face therapy.^[11] Further, Internet-delivered interventions may also be more flexible than face-to-face interventions, allowing people to follow the treatment outside office hours or in the weekend.^[13] Finally, it has been assumed that Internet interventions are more cost effective than face-to-face interventions and may reduce waitlists.^[10] Similar to group CBT, they may be used by many people at the same time.^[10] Meta-analyses have shown that Internet-delivered interventions are as effective as face-to-face interventions in the treatment of depression^[14] and anxiety disorders such as panic disorder and phobias.^[15,16] However, disadvantages of Internet-delivered interventions have also been described, such as a low adherence^[17] and the requirement of computer skills and literacy.^[10] A disadvantage specific for Internet-delivered PTSD treatment may be that during imaginal exposure distress levels may—temporarily—increase. The absence of a therapist who would otherwise mitigate distress may be problematic and potentially increase the risk for adverse events.

Interapy was one of the first Internet-delivered CBTs (iCBTs) developed for the treatment of trauma-related symptoms.^[8] It has been tested in several randomized controlled trials (RCTs) in individuals exposed to adverse events^[18,19] and bereavement.^[20] During Interapy, individuals are asked to describe details of the trauma in writing (imaginal exposure), to reappraise

the trauma (cognitive restructuring), and to perform a social sharing and farewell ritual. Subsequent iCBT interventions more closely resemble regular face-to-face CBT and include a broader range of techniques. Litz and colleagues^[21] tested a web-assisted therapist-assisted iCBT intervention in survivors of the 2001 Pentagon attacks and Iraq/Afghanistan combat veterans. Ivarsson et al.^[9] tested the effects of a therapist-assisted intervention for patients with chronic PTSD recruited with advertising consisting of eight weekly text-based modules containing psychoeducation, breathing retraining, imaginal, and in vivo exposure by motivating patients to gradually enter situations that are avoided in everyday life. A similar therapist-assisted iCBT intervention consisting of four lessons for website visitors diagnosed with PTSD was developed by Spence and colleagues.^[22] Mouthaan et al.^[23] evaluated a self-help web-based intervention to prevent PTSD in injury survivors. This intervention consisted of psychoeducation, instructions to exposure exercises, and anxiety management via audio exercises.^[23] Steinmetz et al.^[24] tested the effects of an iCBT self-help intervention in hurricane survivors focused on strengthening coping skills. The most prominent components of this intervention were psychoeducation, stress management, strengthening social support, and promoting self-talk skills.^[24]

A previous meta-analysis examined the effectiveness of telehealth interventions for PTSD symptoms.^[25] This meta-analysis included a broad variety of PTSD telehealth interventions: interventions delivered through the Internet, videoconferencing, or telephone. It was found that the telehealth interventions were more effective when compared to waitlist control, whereas they were less effective when compared to face-to-face treatments. When the cognitive behavioral telehealth interventions were compared with supportive counseling telehealth interventions, there was no difference.^[25] However, the meta-analysis is limited by the fact that it included only 11 studies, two of which lacked a comparison condition.^[8,26] In addition, the included studies were very different: one study included an intervention not primarily focused on PTSD but on anger management,^[27] and one focused on preventing symptoms of PTSD.^[28] Additionally, since publication of this meta-analysis, three RCTs were carried out examining the effectiveness of Internet-delivered interventions for PTSD.^[9,29,30] Finally, this meta-analysis did not distinguish between the effects of therapist-assisted and self-guided interventions.

A few potential moderators may influence the effectiveness of Internet-delivered interventions.^[31,32] First, it is yet unclear whether therapist-assisted interventions for PTSD are more effective than self-help interventions. A recent meta-analysis on iCBT for anxiety disorders compared therapist-assisted to self-help iCBT for social phobia, and did not find a difference.^[33] Other studies indicated an advantage of therapist-assisted interventions in the treatment of depression^[14] or anxiety.^[16] Another moderator that has yet to be investigated in

relation to the effectiveness of iCBT for PTSD symptoms is treatment duration.^[34] Moreover, no studies have yet compared iCBT with exposure versus without exposure. This may be relevant, as exposure to the traumatic memory is considered an essential element of PTSD treatment.^[7] Finally, concerns have been raised about the recruitment type of study participants.^[32,33] Many Internet-delivered intervention studies recruit participants from the community via media advertisements, but it has been suggested that these participants are less symptomatic than clinically referred patients (see^[33]). It may be hypothesized that iCBT for PTSD is more effective in community recruited patients with lower levels of PTSD symptoms.

This systematic review and meta-analysis of RCTs investigates the effectiveness of iCBT compared to waitlist control and other interventions in reducing PTSD symptoms and comorbid depression. In addition, we will examine the following moderators for the effectiveness of iCBT for PTSD symptoms: presence of therapist support, treatment duration, whether or not imaginal and/or in vivo exposure was used, inclusion based on clinical PTSD diagnosis versus elevated levels of posttraumatic stress (PTS), type of recruitment, and study quality.

METHODS

The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement was used as a guide to conduct the meta-analysis and in the reporting of the results.^[34]

SELECTION OF STUDIES

The following databases were searched: the Cochrane Central Register of Controlled Trials (CCRCT), PsychINFO, PubMed, Web of Science, and Embase. Titles and abstracts were identified by combining key words, text words, and MeSH terms in which words indicative of Internet-delivered interventions (e.g. Internet, online, computer) were combined with words indicative of treatment (e.g. intervention, therapy, CBT) and PTSD symptoms (e.g., posttraumatic stress disorders, PTSD, posttraumatic; see Supporting Information Appendix SA). Additionally, the reference lists of previous meta-analyses and reviews were considered and searched for relevant articles.^[25,35]

Studies had to fulfill the following inclusion criteria: (1) iCBT intervention, (2) full-text available, (3) includes (information to calculate) effect sizes, (4) a PTSD outcome measure is used (self-report instrument or clinical diagnosis), (5) RCT comparing iCBT to an active control condition (e.g. psychoeducation, supportive counseling, or face-to-face therapy) or inactive control (e.g. waitlist or treatment-as-usual (TAU)), and (6) original data are presented not used in another study. Since iCBT for PTSD is a relatively recent topic, a low number of RCTs was expected. Thus, we considered both studies that included participants with a clinician-obtained diagnosis of PTSD and patients with elevated levels of PTSD symptoms based on a PTSD self-report instrument. It has been found that individuals with subclinical levels of PTSD show similar levels of impairment (e.g., suicide and hopelessness) as patients with a full diagnosis of PTSD.^[36] In addition, it will also allow us to examine whether PTSD severity is a moderator of iCBT outcomes.

CODING PROCEDURES

The inactive control conditions included waitlist and TAU, whereas the other interventions included iCBT without exposure, psychoeducation, and supportive counselling. The interventions were coded as being either therapist-assisted or self-help. Since the average number of sessions in the meta-analysis was eight (range 6–10), treatment was coded as short when it was below or equal to eight sessions and long when it was more than eight sessions. iCBT interventions were coded as containing exposure (imaginal, in vivo or both), or containing no exposure at all. The study samples were coded as subclinical PTSD or a full PTSD diagnosis, i.e. meeting PTSD diagnostic criteria according to DSM-IV.^[37] Methodological quality was coded as high (three or more quality criteria fulfilled) and low (less than three quality criteria).

QUALITY ASSESSMENT

The methodological quality of the selected studies was assessed with four criteria of the Cochrane Handbook for Systematic Reviews of Interventions:^[38] (1) adequate sequence generation; (2) allocation concealment; (3) blinded assessments; (4) intention-to-treat. The methodological quality of the studies was assessed by two independent raters.

STATISTICAL ANALYSIS

The meta-analysis was conducted using the CMA software.^[39] Separate analyses were conducted to compare iCBT to waitlist and other interventions. The analyses were conducted for PTSD scores at post-treatment, since only a few studies reported follow-up data. Secondary outcome was depressive symptoms. Hedges' g was computed as between-group effect size, comparing an iCBT intervention to control. The effect size is considered small when $g = .20$, medium when $g = .50$, and large when $g = .80$.^[39] For studies that contribute with more than one effect size to the analysis, such as the use of more than one PTSD outcome measure, the data were combined within CMA. The pooled effect sizes were calculated by using the random effects model. The Q statistic was used to test the significance of homogeneity, and the I^2 statistic was used to indicate the magnitude of the heterogeneity. With the I^2 statistic, 0% indicates no heterogeneity, 25% low, 50% moderate, and 75% high heterogeneity.^[40] Using the mixed-effects model, the following exploratory subgroup analyses were carried out: role of support (therapist-assisted vs. self-help), treatment duration (≤ 8 sessions vs. > 8 sessions), iCBT with imaginal or in vivo exposure versus iCBT without any type of exposure, clinical characteristics of the sample (clinical PTSD diagnosis versus elevated PTSD symptoms), recruitment (community vs. clinical referral), and study quality (high vs. low). Subgroup analyses were only conducted when at least three or more comparisons were available in each subgroup. Publication bias was tested by examining the funnel plot, the Duval and Tweedie's trim and fill procedure,^[41] and Egger's test^[42] as implemented in CMA.

RESULTS

A flow diagram of the inclusion of studies is presented in Figure 1. A total of 12 studies (14 comparisons, 1,306 participants) were included (Table 1). All studies included adult participants, except Wang, Wang, and Maercker,^[43] which also included six participants younger than 18, but did not present separate results for children and adults.

Ten studies included a comparison of iCBT to an inactive control group, of which nine included a waitlist control group^[9,18,19,22,29,30,43,44] and one included a TAU group.^[24] Three studies included a comparison of iCBT to other interventions, which were Internet-delivered

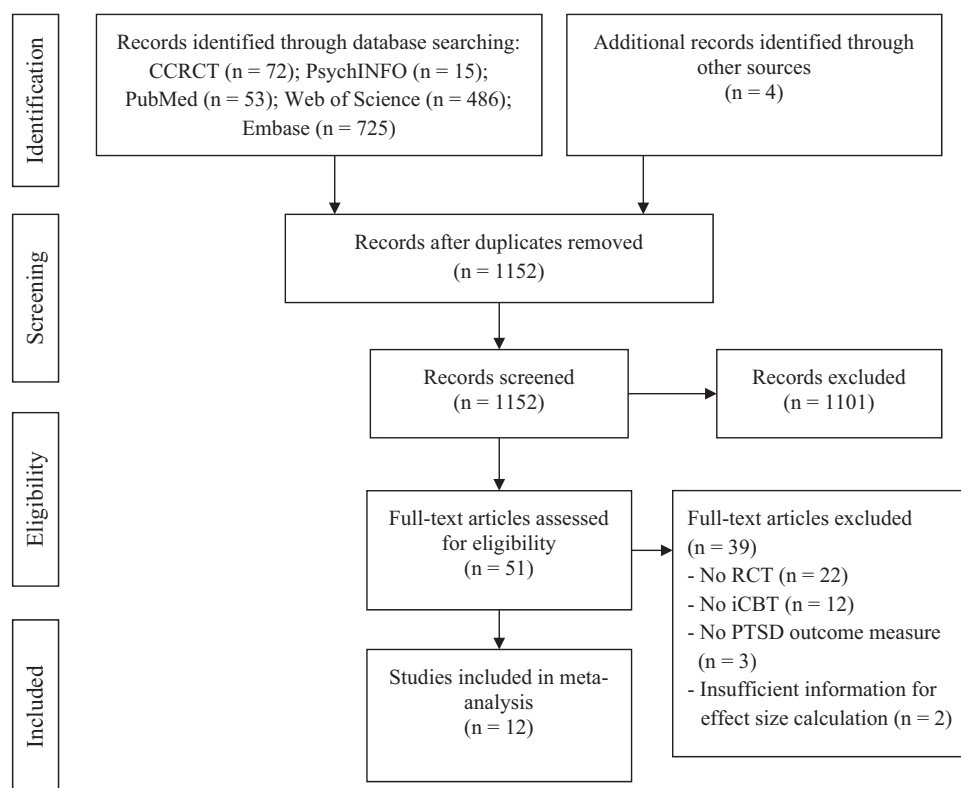


Figure 1. Flowchart of included studies.

psychoeducation,^[24] Internet-delivered supportive counseling,^[21] and iCBT without exposure.^[45] The participants were recruited from the community in seven of the studies,^[9, 18, 19, 22, 30, 43, 44] and in five studies they were recruited both from the community and clinical settings.^[20, 21, 24, 29, 45] Six studies^[9, 21, 22, 24, 30, 43] offered eight or less sessions and six studies^[18–21, 29, 44] offered more than eight sessions. Five studies included participants meeting a PTSD diagnosis^[9, 21, 22, 29, 45] and six studies also included participants with subclinical levels of PTSD (i.e., elevated scores on a PTSD self-report instrument^[18–20, 24, 43, 44] or combat veterans with problem drinking behavior and PTSD symptoms.^[30] Seven studies recruited participants with mixed types of trauma,^[9, 18, 19, 22, 43–45] while the other studies included combat,^[30] pregnancy loss,^[29] terrorism and combat,^[21] natural disaster,^[24] or bereavement.^[20] In terms of therapist support, seven studies included therapist-assisted iCBT through email,^[9, 18–20, 29, 44] two included email and telephone,^[21, 45] and one with additional face-to-face meetings.^[21] Three studies included self-help treatments.^[24, 30, 43] Eleven studies assessed depression as a secondary outcome.^[9, 18–22, 24, 29, 43–45] Only one study was conducted in a non-Western country, i.e. China.^[43]

The iCBT protocols in all studies included psychoeducation and cognitive restructuring. Seven studies included anxiety management techniques.^[9, 21, 22, 24, 30, 43, 45] Ten studies included imaginal exposure, nine of

which administered writing assignments about the experience,^[9, 18–21, 29, 30, 44, 45] and one had participants listen to audiotapes.^[22] Four studies also included gradual in-vivo exposure exercises integrated into the homework assignments.^[9, 21, 22, 45] Three studies did not include any type of exposure to the traumatic memory in the intervention.^[24, 43, 45] Five studies included a social sharing and farewell ritual.^[18–20, 29, 44]

QUALITY ASSESSMENT

The methodological quality of the included studies varied. One study (8%) met all four criteria,^[9] five studies (42%) met three of the criteria,^[18, 22, 29, 30, 44] and six studies (50%) met two of the criteria.^[19–21, 24, 43, 45] Four studies did not have an adequate sequence generation.^[20, 21, 24, 30] Eight studies did not provide adequate information on allocation concealment.^[19–21, 24, 43–45] Three studies had no blinding of outcome assessments,^[22, 43, 45] and two studies provided insufficient information on blinding of assessments.^[18, 19] Two studies reported completers-only analysis,^[20, 21] and ten reported intention-to-treat analysis.^[9, 18, 19, 22, 24, 29, 30, 43–45]

EFFECTS OF ICBT COMPARED TO WAITLIST AND TAU CONTROLS

Figure 2 shows the forest plot of effect sizes for iCBT compared to inactive controls (waitlist and TAU).

TABLE 1. Selected characteristics of included studies

Study	N	Recruitment	Diagnostic criteria	Type of trauma	Control	Therapist assistance	Number of sessions	Outcome measures	Study quality ^a	Location
Brief et al. (2013)	315	Community	PTS	Combat	WL	Self-help	8	PCL-5	– + + +	US
Ivarsson et al. (2014)	62	Community	PTSD	Mixed	WL	Therapist-assisted	8	CAPS, IES-R, PDS, BDI-II	+ + + +	Sweden
Kersting et al. (2013)	228	Mixed	PTSD	Pregnancy loss	WL	Therapist-assisted	10	IES-R, BSI	+ – + +	US
Knaevelsrud et al. (2007)	95	Community	PTS	Mixed	WL	Therapist-assisted	10	IES-R, BSI	+ – + +	Germany
Lange et al. (2001)	25	Community	PTS	Mixed	WL	Therapist-assisted	10	IES, SCL-90	+ + + –	Netherlands
Lange et al. (2003)	101	Community	PTS	Mixed	WL	Therapist-assisted	10	IES, SCL-90	+ – + –	Netherlands
Litz et al. (2007)	18	Mixed	PTSD	Terrorism/Combat	Supportive counselling	Therapist-assisted	10	PSS-IV, BDI-II	– – + +	US
Spence et al. (2011)	42	Community	PTSD	Mixed	WL	Therapist-assisted	7	PCL-C, PHQ-9	+ + – +	Australia
Spence et al. (2014)	125	Mixed	PTSD	Mixed	iCBT (NoExp)	Therapist-assisted	6	PSS-IV, IES-R, PHQ-9	+ – – +	Australia
Steinmetz et al. (2012)	37	Mixed	PTS	Natural disaster	TAU	Self-help	6	MPSS, CES-D	– – + +	US
Wagner et al. (2006)	51	Mixed	PTS	Bereavement	Psychoed	Therapist-assisted	10	IES, BSI	– – + +	Europe
Wang et al. (2013)	90	Community (urban)	PTS	Mixed	WL	Self-help	6	PDS, SCL-90	+ – – +	China
	93	Community (rural)	PTS		WL		6			

PTSD, clinical posttraumatic stress disorder diagnosis; PTS, elevated levels of PTSD symptoms; iCBT (NoExp), internet-delivered cognitive behavioral therapy without exposure; WL, waitlist; TAU, treatment-as-usual; Psychoed, internet-delivered psychoeducation; PCL-5, PTSD checklist 5; CAPS, Clinician Administered PTSD Scale; IES-R, Impact of Events Scale – Revised; PDS, Posttraumatic Stress Diagnostic Scale; BDI-II, Beck Depression Inventory – II; BSI, Brief Symptom Inventory; IES, Impact of Events Scale; SCL-90, Symptom Checklist; PSS-IV, PTSD Symptom Scale – Interview Version; PCL-C, PTSD Checklist – Civilian Version; PHQ-9, Patient Health Questionnaire; MPSS, Modified PTSD Symptom Scale; CES-D, Center for Epidemiologic Studies Depression Scale;

^aA positive or negative sign is given for four quality criteria: sequence generation, allocation concealment, blinding of outcome assessors, and intention-to-treat.

The pooled effect size of the 11 comparisons (10 studies, 1,139 participants) at posttreatment was moderate ($g = 0.71$, 95% CI [0.49–0.93], $P < .001$), and the heterogeneity was moderate ($I^2 = 64.52$, 95% CI [32–81]) (Table 1). Removing each study as a possible outlier did not importantly affect effect sizes. The largest increase occurred when removing the study of Brief et al.^[30] and resulted in a Hedges' g of 0.80 (95% CI [0.66–0.94]). The largest decrease in effect size was found when removing Kersting et al.^[29] and resulted in an Hedges' g of 0.60 (95% CI [0.46–0.73]).

In line with the results for PTSD symptoms, iCBT interventions also showed a moderate overall pooled effect size when compared to waitlist on symptoms of depression ($g = 0.62$, 95% CI [0.39–0.85], $P < .001$). Heterogeneity was moderate ($I^2 = 55.76$, 95% CI [7–79]) (Table 2).

EFFECTS OF ICBT COMPARED TO OTHER INTERVENTIONS

Figure 3 shows the forest plot of effect sizes for iCBT compared to other interventions. The pooled effect size of the three comparisons (3 studies, 193 participants) at posttreatment was small ($g = 0.28$, 95% CI [–0.00–0.56], $P = .05$), and the heterogeneity was low ($I^2 = 0$). The overall pooled effect size of iCBT compared to other interventions on symptoms of depression was non-significant ($g = 0.44$, 95% CI [–0.04 to 0.91], $P = .070$). Heterogeneity was low ($I^2 = 0$).

EXPLORATORY SUBGROUP ANALYSES

Table 2 shows the subgroup analyses of iCBT compared to waitlist for PTSD symptoms. Subgroup analyses showed a significantly larger pooled effect

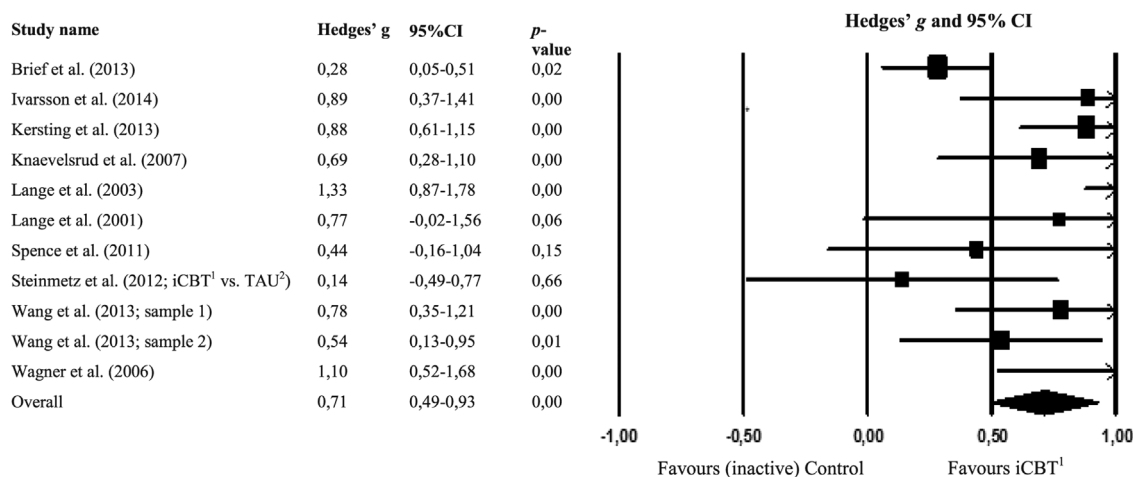


Figure 2. Standardized effect sizes of iCBT compared with waitlist and TAU controls: Hedges' *g*.

size ($P = .006$) for iCBT with therapist support ($g = 0.89$, 95% CI [0.70–1.08]) than self-help iCBT ($g = 0.50$, 95% CI [0.22–0.78]). We also found a significantly larger pooled effect size ($P = .03$) for iCBT with more than eight sessions ($g = 0.95$, 95% CI [0.71–1.19]) than for iCBT with eight or less sessions ($g = 0.49$, 95% CI [0.28–0.71]). No significant differences in effect sizes were found comparing iCBT with imaginal and/or in vivo exposure versus iCBT without any type of exposure ($P = .34$), clinical PTSD diagnosis versus elevated levels of PTS ($P = .75$), community versus mixed (community

and clinical) samples ($P = .87$), and high versus low quality studies ($P = .50$). No subgroup analyses were conducted for comparing iCBT to other interventions since there were less than three studies per subgroup.

Table 3 shows the overall effects and subgroup analyses of iCBT compared to waitlist and TAU controls for depression symptoms. The subgroup results for iCBT compared to waitlist and TAU controls for depression symptoms showed no significant differences in effect size for iCBT with therapist support versus self-help iCBT ($P = .69$), shorter versus longer iCBT ($P = .41$), iCBT with exposure versus without exposure ($P = .69$),

TABLE 2. Effectiveness of iCBT compared to waitlist and TAU for PTSD symptoms

Study	<i>N</i> _{comp}	Hedges' <i>g</i>	95% CI	<i>Q</i>	<i>I</i> ²	df	95% CI ^a	<i>P</i> ^b
Overall	11	0.71	0.49–0.93	28.19	64.52	10	32–81	
Therapist support								.006
Therapist-assisted	7	0.89	0.70–1.08	7.18	16.45	6	0–60	
Self-help	4	0.50	0.22–0.78	5.18	42.13	3	0–81	
Treatment duration								.03
Long	5	0.95	0.71–1.19	4.83	17.17	4	0–83	
Short	6	0.49	0.28–0.71	8.27	39.51	5	0–76	
Exposure								.34
Exposure-based iCBT	8	0.78	0.51–1.05	24.90	71.89	7	42–86	
No exposure	3	0.52	0.08–0.97	2.74	26.92	2	0–92	
Diagnostic criteria								.75
PTSD	3	0.77	0.34–1.20	1.79	0	2	0–90	
PTS	8	0.64	0.24–0.95	23.28	69.93	7	37–86	
Recruitment								.87
Community	7	0.72	0.44–1.01	19.61	69.40	6	33–86	
Mixed	4	0.72	0.29–1.08	6.89	56.44	3	0–86	
Study quality								.50
High	6	0.64	0.35–0.94	13.38	62.63	5	9–85	
Low	5	0.80	0.46–1.13	11.94	66.51	4	13–87	

*N*_{comp}, number of comparisons; CIs, confidence intervals; PTSD, clinical posttraumatic stress disorder (PTSD) diagnosis; PTS, elevated levels of PTSD symptoms.

^a95% confidence intervals around *I*².

^bThe *P* values indicate the significance between the effect sizes in the subgroups.

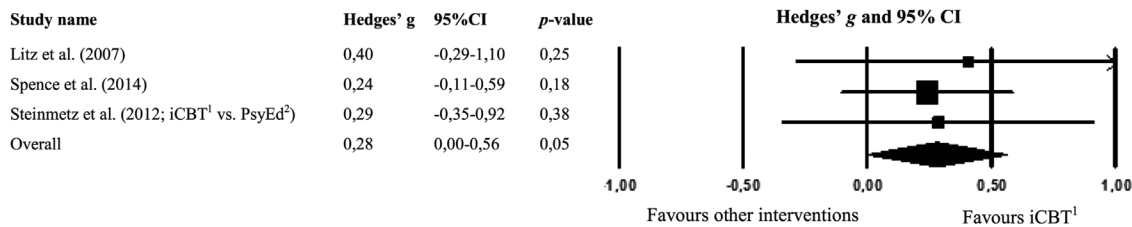


Figure 3. Standardized effect sizes of iCBT compared with other interventions: Hedges' g.

community versus mixed samples ($P = .80$), and high versus low quality studies ($P = .55$). Since there were less than three studies per subgroup, no subgroup analyses were conducted for comparing clinical PTSD diagnosis versus elevated PTSD levels. For the same reason, no subgroup analyses were carried out for comparing iCBT to other interventions.

PUBLICATION BIAS

When comparing iCBT to waitlist, visual inspection of the funnel plot and Egger's test ($P = .34$) did not indicate the presence of publication bias. The Duval and Tweedie's trim and fill procedure identified no missing studies, since after adjustment for publication bias the mean effect size did not change.

DISCUSSION

The aim of this systematic review and meta-analysis was to give an overview of RCTs that examined the effectiveness of iCBT for PTSD symptoms and comorbid depression. We found that iCBT was superior to inactive controls such as waitlist and TAU, and the

effects were strongest when iCBT interventions were therapist-assisted and longer than eight sessions. Results were largely similar with respect to depression symptoms, however therapist support and longer treatment duration was not associated with a stronger effect there. We also found a trend suggesting that iCBT was somewhat more effective than the active controls such as psychoeducation and supportive counseling.

The findings of this meta-analysis were similar to the findings of a previous meta-analysis on telehealth interventions for PTSD symptoms^[25] in that these treatments were more effective than waitlist control. Unlike the Sloan et al.^[25] meta-analysis, which suggested superiority of face-to-face treatments and did not find a significant difference between telehealth and supportive counseling, our results show that iCBT is superior to waitlist, and a trend suggested that iCBT is more effective than active controls (e.g., psychoeducation and supportive counseling). The reason for these differences is likely due to the fact that Sloan et al.^[25] included a more heterogeneous set of interventions. However, the results of the current meta-analysis are in line with previous meta-analyses on Internet-delivered interventions for symptoms of depression and anxiety, showing that

TABLE 3. Effectiveness of iCBT compared to waitlist and TAU controls for depressive symptoms

Study	N_{comp}	g	95% CI	Q	I^2	df	95% CI ^a	p^b
Overall	9	0.62	0.39–0.85	18.08	55.76	8	7–79	
Therapist support								.69
Therapist-assisted	6	0.66	0.36–0.96	8.50	41.18	5	0–77	
Self-help	3	0.55	0.12–0.98	9.35	78.61	2	31–93	
Treatment duration								.41
Long	5	0.71	0.39–1.03	7.24	44.75	4	0–80	
Short	4	0.51	0.14–0.87	9.77	69.31	3	9–89	
Exposure								.69
Exposure-based iCBT	6	0.66	0.36–0.96	8.50	41.18	5	0–77	
No exposure	3	0.22	0.12–0.98	9.35	78.61	2	31–93	
Recruitment								.80
Community	6	0.65	0.33–0.96	16.86	70.34	5	31–87	
Mixed	3	0.58	0.14–1.0.1	1.23	0.00	2	0–90	
Study quality								.52
High	4	0.54	0.18–0.89	3.89	22.91	3	0–88	
Low	5	0.69	0.37–1.02	13.03	69.29	4	21–88	

N_{comp} , number of comparisons; CIs, confidence intervals; PTSD, clinical posttraumatic stress disorder diagnosis; PTS, elevated levels of PTSD symptoms.

^a95% confidence intervals around I^2 .

^bThe P values indicate the significance between the effect sizes in the subgroups.

Internet-delivered interventions are more effective than waitlist,^[15] and are not less effective than face-to-face treatments.^[14,16]

The larger effects for therapist-assisted compared to self-help iCBT are in line with previous meta-analyses on computerized interventions for symptoms of depression and anxiety, finding moderate-to-large treatment effects in favor of therapist-assisted iCBT.^[14–16] Perhaps contact with a therapist may increase motivation to complete homework exercises, increase adherence, and promote individual tailoring of the intervention.^[10] Moreover, we found that longer iCBT programs were more effective in reducing PTSD symptoms than shorter programs. This indicates a dose–response relationship between the number of sessions and the effectiveness of iCBT, which would need further exploration. In the field of PTSD, there is a lack of studies examining how many sessions are needed for optimal treatment response. A study on face-to-face psychotherapy for depression found that on the long-term 16 sessions were more effective than eight sessions.^[46]

It may be surprising that a trend suggested that iCBT were somewhat more effective than the other active interventions. However, this finding is inconclusive because of the limited number of studies. It should also be noted that the main active ingredient of two of three active control treatments was psychoeducation, which has been shown to have only a small effect on reducing psychological distress.^[47] Future studies should compare iCBT for PTSD to treatments of choice such as face-to-face CBT.

This meta-analysis promotes the use of iCBT in clinical settings, potentially as part of blended care strategies. Preferably, iCBT interventions are therapist-assisted, and measures should be taken to enhance uptake and ensure patients' motivation to finish iCBT intervention of longer duration. Note, however, that self-help iCBT showed a moderate effect size in our meta-analysis, and it may still be offered to clients preferring self-help treatments or in situations where therapist support is unavailable.^[33]

A primary limitation of this meta-analysis was that the number of included studies was relatively low. This may have hampered the ability to detect subgroup effects due to insufficient statistical power (i.e. type II error). Furthermore, we found moderate statistical heterogeneity, which casts uncertainty about the effects. Lastly, no conclusions may be made about the long-term effectiveness of iCBT for PTSD, due to the limited available follow-up data.

Future studies may evaluate iCBT across various types of trauma samples, examine its long-term effects, and examine relevant mediators and moderators for iCBT treatment success, such as the type of trauma experienced, baseline severity of symptoms of PTSD and depression, and the amount of therapist support needed to optimize treatment effect. In addition, studies may develop and evaluate iCBT as part of stepped or blended care models and compare its effectiveness to

evidence-based other interventions such as face-to-face trauma-focused CBT. Furthermore, future studies could directly compare therapist-assisted versus self-help iCBT for PTSD and shorter versus longer iCBT programs

CONCLUSION

The findings of this systematic review and meta-analysis supplement understanding of Internet-delivered interventions by showing that iCBT, particularly with some component of therapist-support, is an effective treatment for individuals with PTSD symptoms. Accordingly, iCBT may be a promising alternative to traditional PTSD treatments.

Acknowledgment. The authors thank Eirini Karyotaki.

Conflicts of interest. The authors declare no conflicts of interest or financial disclosures related to this work.

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